REMARKS

Claims 51-61 are now presented for examination. Claim 57 has been canceled without prejudice or disclaimer of subject matter. Claims 51, 53-55, 59 and 61 have been amended to define still more clearly what Applicant regards as his invention, in terms which distinguish over the art of record. Support for the amended claims can be found in the specification. Claim 51 is the only independent claim.

Claims 51-61 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,243,195 to Nishi in view of U.S. Patent No. 4,566,795 to Matsuura et al., further in view of U.S. Patent No. 6,384,898 to Inoue et al. and still further in view of U.S. Patent No. 4,711,567 to Tanimoto. With regard to the claims as currently amended, this rejection is respectfully traversed.

Independent Claim 51 as currently amended is directed to exposure apparatus that exposes a wafer to a pattern. In the apparatus, a stage is configured to hold the wafer and move. A scope has an image sensor and is configured to obtain image data. The image sensor is configured to store image signals corresponding to an image of the wafer formed on the image sensor during the image sensor image storage period and to supply the stored image signals as the image data. The mark is held by the stage. A laser interferometer is configured to measure the deviation of the stage, the deviation being the difference between the target position of the stage and the actual position of the stage. A controller is configured to calculate the average of plural

deviations of the stage measured by the laser interferometer during the image storage period to calculate the position of the mark based on the image data obtained by the scope and the data of the calculated average and to control the position of the stage based on the calculated position of the mark.

In Applicant's view, Nishi discloses exposure apparatus that exposes mask patterns on a sensitive plate. In the apparatus, there is a set (for X and Y direction) of a laser interferometer measures a position of a wafer stage and satisfies Abbe's condition with respect to a projection lens and a set (for X and Y direction) of the laser interferometer and satisfying Abbe's condition with respect to off-axis alignment system. When a fiducial mark on the wafer stage is positioned directly under the projection lens, a presetting is performed so that measuring values by the two sets of laser interferometers are equal to each other.

In Applicant's opinion, Matsuura et al. discloses alignment apparatus that aligns one of the substrates with the other by means of first and second reference marks and has scanning means including a light beam generating means for reciprocally scanning first and second areas respectively by a light beam. Discrimination means generates a discrimination signal indicative of the scanning direction by the scanning means in synchronism with the scanning. First photoelectric means generates a first signal when the first photoelectric means receives the light beam transmitted through a first area and is separated by the first reference mark. Second photoelectric means generates a second signal when the second photoelectric means receives the light beam transmitted through the second area and is separated by the second reference mark. Operation means determines the direction and amount of the relative deviation between the first

and second reference marks from the first and second signals and from the discrimination signal. Means moves one of the substrates relative to the other in response to the operation means. The alignment apparatus enables the alignment of a wafer with a reticle or mask at higher speed and with higher precision.

Inoue et al., in Applicant's view, discloses projection exposure apparatus in which light from an alignment illumination system having a flash lamp is bent by a beam splitter to be illuminated onto an alignment mark on a wafer through a microscope optical system. An alignment signal treatment system reads output values from wafer stage interferometers at the same time the flashing light is emitted from the flash lamp of the alignment illumination system. Since an image of the alignment mark focused on an imaging element is generated only when the flashing light is emitted, X, Y coordinate values representing a position of a wafer stage upon emission of the flashing light indicate X, Y coordinate values of the position of the wafer stage at the time when the image of the alignment mark is measured by the imaging element. An imaging element such as a CCD images a wafer alignment mark multiple times in synchronization with emission of pulse light while shifting a wafer stage. A plurality of image data are sampled and stored. A position of the wafer stage upon emission of the pulse light is measured by interferometers and stored. When the plural image data are added, a shift amount of the wafer stage is taken into consideration. For example, if the shift amount of the wafer stage within a time period between two successive light emissions corresponds to two pixels, the image data are deviated by two pixels. The signal may also be deviated by interpolation calculation.

Tanimoto, in Applicant's opinion, discloses exposure apparatus that optically transfers a pattern of a circuit such as an integrated circuit on a semiconductor wafer. The positioning control of stepping movement of a movable stage holding the wafer thereon is effected in such a manner that even if a rotational displacement is present in the optical image of a mask pattern with respect to the moving coordinate axes of the stage, the rotational displacement is substantially cancelled in a printed pattern.

According to the invention of Claim 51, a controller is configured to calculate an average of the plural deviations of a stage measured by a laser interferometer during an image storage period to calculate the position of a mark based on the image data obtained by the scope and the calculated average data. The position of the stage is controlled based on the calculated position of the mark.

Nishi teaches a projection exposure apparatus that has two image sensing systems and a plurality of interferometric systems for measuring a reticle stage at a plurality of points and a wafer stage at a plurality of points. As recognized by the Examiner, Nishi does not explicitly disclose averaging plural stage positions. Further, Nishi fails in any manner to teach or suggest measuring deviations and calculating the <u>average of plural deviations</u> as in Claim 51. Further, it has not been asserted that Matsuura et al. suggests the feature of measuring deviations and calculating the average of such deviations as in Claim 51.

Inoue et al. cited as teaching averaging discloses at lines 2-13 of column 10 that "the wafer mark and the index pattern are imaged by several times in synchronous with pulse light while moving the wafer stage continuously, and the position of the wafer mark is detected on the

basis of the plurality of images. The position of the wafer stage is detected whenever the wafer mark and the index pattern are imaged, and when the plurality of images are averaged (for example, when the images are added), by correcting the positional deviations of the wafer stage upon acquirement of respective image data and by adding the corrected data, the position of the wafer mark is detected with high accuracy."

From line 67 of column 12 to line 12 of column 13, Inoue et al. states "since the wafer stage 105 is being shifted, the respective image data are deviated in the measuring direction (x direction) by a small amount corresponding to the product of the shifting speed of the wafer stage 105 and the interval of light emission. ...The plurality of image data CD1, CD2, CD3, ..., CDn are corrected on the basis of the positional information of the wafer stage 105 corresponding to the respective pulses and then are added, thereby composing the final positioning data with no blur." and, at lines 18-28 of column 13, Inoue et al. further discloses "However, normally, since the length of the wafer marks in the measuring direction is several tens of μm (in total), the visual field of the imaging element becomes about 100μm on the wafer W. When it is assumed that the number of pixels of the imaging elements is 1024 channels (pixels), the length of one pixel becomes 100 nm or less, which is considerably greater than 10-20 nm ... and approximates to the positioning allowable area range for the alignment. In such a case, it is preferable that, after primary or secondary interpolation between the adjacent pixels is effected, the addition is made." Accordingly, the Inoue et al. arrangement is restricted to teaching that acquisition of image data and detection of positional information of a wafer stage are performed for every one light pulse and each image data is corrected on the basis of the

positional information of the wafer stage obtained at the time of image capturing. In Inoue et al., only images of marks are averaged. There is no suggestion of calculating an average of deviations. Accordingly, Inoue et al. is devoid of any disclosure of the feature of Claim 51 relating to calculating an average of a plurality of deviations of a stage measured by a laser interferometer during an image storage period.

Tanimoto has been cited as teaching averaging the stage position to get an accurate position of an image. Applicant finds that Tanimoto discloses only that the image of a slit is scanned by a slit opening and a photoelectric sensor and that the center line of the slit image is determined using the average of two positions of the stage where corresponding photoelectric signals are equal to a standard value. There is, however, no suggestion in Tanimoto of the feature of Claim 51 of calculating an average of a plurality of deviations of a stage measured by a laser interferometer during an image storage period.

With regard to the cited combination, it is not seen that any of Nishi, Matsuura et al., Inoue et al. and Tanimoto or any combination thereof teaches or suggests the feature of Claim 51 of calculating an average of a plurality of the deviations of a stage measured by said laser interferometer during an image storage period, to calculate a position of the mark based on the image data obtained by said scope and data of the calculated average, and to control a position of said stage based on the calculated position of the mark. Accordingly, it is believed that Claim 51 as currently amended is completely distinguished from any combination of Nishi, Matsuura et al., Inoue et al. and Tanimoto and is allowable.

For the foregoing reasons, Applicant submits that the present invention, as recited in independent Claim 51, is patentably defined over the cited art, whether that art is taken individually or in combination.

Dependent claims 52-56 and 58-61 also should be deemed allowable, in their own right, for defining other patentable features of the present invention in addition to those recited in independent Claim 51. Individual consideration of these dependent claims is requested.

Applicant further submits that the instant application is in condition for allowance. Favorable reconsideration, withdrawal of the rejections set forth in the above-noted Office Action and an early Notice of Allowance are requested.

Applicant further submits that this Amendment After Final Action clearly places this application in condition for allowance. This Amendment was not earlier presented because Applicants believed that the prior Amendment placed the application in condition for allowance. Accordingly, entry of the instant Amendment, as an earnest attempt to advance prosecution and reduce the number of issues, is requested under 37 CFR 1.116.

Applicant's Attorney, Steven E. Warner, may be reached in our Washington, D.C. office by telephone at (202) 530-1010. All correspondence should continue to be directed to our below listed address.

Respectfully submitted,

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